UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND FABRICATE PORTABLE WASTE ENGINE OIL FILTRATION UNIT FOR AUTOMOTIVE SERVICES CENTRE

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BACHELOR OF AUTOMOTIVE ENGINEERING TECHNOLOGY (BMMA) WITH HONOURS

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MOHD HARIZ AZFAR BIN MOHD HEDZIR

A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of Mechanical and Manufacturing Engineering Technology (Automotive) (BMMA) with Honours

Faculty of Mechanical and Manufacturing Engineering Technology

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2021

DECLARATION

I declare that this Choose an item. entitled "Design and Fabricate Portable Waste Engine OilFiltration Unit for Automotive Services Centre" is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is notconcurrently submitted in candidature of any other degree.

Signature : 

Name : MOHD HARIZ AZFAR BIN MOHD HEDZIR

Date : 17/1/2022

APPROVAL

I hereby declare that I have checked this thesis and, in my opinion, this thesis is adequate interms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering Technology (Automotive) with Honours.

Signature : 

Supervisor Name : DR. MUHAMMAD ILMAN HAKIMI CHUA BIN ABDULLAH

Date : 18/1/2022

DEDICATION

Alhamdulillah, thanks and praise to the Almighty Allah S.W.T. This thesis is dedicated tomy dearest family, my parents, my supervisor, my lecturers and all of my friends. Thanksfor their encouragement and support.

ABSTRACT

The aim of this thesis is to develop a new method of improving wasted engine oil treatment.Because of the growing global focus on mineral resources, recycling motor oil is becomingan increasingly useful study in the upcoming years. Various testing and studies on recycledmotor oil have been conducted as a result of this. Before each test, waste motor oil is filteredinto a raw oil that can be used for testing and research. ASTM D7317 is a common waste engine oil filtering method that indicates good efficiency, since the filtered waste motor oil is devoid of pollutants and metals, as well as the standard for building a compact oil filter. The study began with the concept of a portable oil filter, utilising various modelling methodologies to pick the appropriate material and concept, as well as to address countermeasures to the technical issues that arose during the construction of the portable oilfilter. Improvement were made by treating the waste engine oil, recycled oil can be reused in automobile engines. The results of this paper were compared to base oils. The concepts of methods for designing and manufacturing the portable oil filter, as well as computer analytical methodologies and SolidWorks 2021 and Computation Fluid Dynamic (CFD) programmes, are covered in Chapter 3. The portable waste engine oil filter is built of nylon manufactured by 3D Laser Selective (SLS) process printers and stainless steel that is designed to handle the volume of a vehicle's motor oil filtering (about 5ml). The filter material is cellulose paper with a high pressure and retention rate. Prior to the production of a portable oil filter, SolidWorks 2021 technology is used to conduct research using machine aid tools.

ABSTRAK

Tujuan tesis ini adalah untuk mengembangkan kaedah baru untuk memperbaiki rawatan minyak enjin terbuang. Kerana tumpuan global yang semakin meningkat pada sumber mineral, kitar semula minyak motor menjadi kajian yang semakin berguna pada tahun-tahun mendatang. Pelbagai ujian dan kajian mengenai minyak motor kitar semula telah dilakukan sebagai hasilnya. Sebelum setiap ujian, minyak motor sisa disaring menjadi minyak mentah yang dapat digunakan untuk ujian dan penyelidikan. ASTM D7317 adalah kaedah penyaringan oli mesin buangan biasa yang menunjukkan kecekapan yang baik, kerana minyak motor sisa yang ditapis tidak mengandungi bahan pencemar dan logam, serta standard untuk membina penapis minyak padat. Kajian ini dimulakan dengan konsep penapis minyak mudah alih, menggunakan pelbagai metodologi pemodelan untuk memilih bahan dan konsep yang sesuai, serta untuk menangani penanggulangan terhadap masalah teknikal yang timbul semasa pembinaan penapis minyak mudah alih. Peningkatan dilakukan dengan mengolah sisa minyak mesin, minyak daur ulang dapat digunakan kembali pada mesin mobil. Hasil makalah ini dibandingkan dengan minyak asas. Konsep kaedah untuk merancang dan membuat penapis minyak mudah alih, serta metodologi analitik komputer dan program SolidWorks 2021 dan Computation Fluid Dynamic (CFD), dibahas dalam Bab 3. Penapis minyak mesin buangan mudah alih terbuat dari nilon yang dihasilkan oleh 3D Pencetak proses Laser Selective (SLS) dan keluli tahan karat yang direka untuk menangani jumlah penapisan minyak motor kenderaan (kira-kira 5mL). Bahan penapis adalah kertas selulosa dengan tekanan dan kadar penahan yang tinggi. Sebelum menghasilkan penapis minyak mudah alih, teknologi SolidWorks 2021 digunakan untuk melakukanpenyelidikan dengan menggunakan alat bantuan mesin yang berada di makmal.

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CHAPTER 1

INTRODUCTION

1.1 Background

Engine oils are created by combining crude oil and its derivatives with other chemicals (additives) to improve their properties. Lubricating oil is used to lubricate enginemoving parts, reduce friction, protect against wear, eliminate pollutants from the engine, andact as a cleaning agent, anticorrosion, and cooling agent. This study focuses on waste engineoil treatment in order to ensure that waste engine oil can be recycled without the use of high-cost materials and is simple to manage.

Waste engine oil is a high-polluting substance that needs careful handling. Used lubricantengine oils are by-products of oil used in vehicles and machinery. Most engine oil contains a lot of different chemicals with very different properties (Demirbas, 2008). When waste engine oil is poured into the field or into water streams, like sewers, it may damage the environment. This could lead to the pollution of groundwater and soil. Recycling the pollutedproducts can save a lot of money on engine oil. In addition, it will have a significant positiveimpact on the environment. The conventional recycling waste engine oil methods either require a high-cost technology such as vacuum distillation or toxic materials such as sulfuricacid. Lubricant oils have been used primarily to reduce friction between moving parts of various machinery or equipment, minimize material wear, improve the efficiency of equipment or machinery, and fuel and energy savings. Lubricants are essential in any modernsociety because they minimize friction and wear by forming a thin liquid film between moving surfaces and removing heat, keeping

equipment clean, and preventing corrosion. Gasoline and diesel engine oils are two of the most effective uses. Engine oil, transmission oil, hydraulic and cutting oils are all examples of waste lubricating oil. It also applies to the contamination of new lubricating components by metals, ash, carbon dust, water, varnish, gums, and other contaminating materials, as well as the formation of asphaltic compounds on the engine's bearing surface. These oils must be changed and removed from the automobile after a few thousand kilometers of driving because of stress from serious deterioration in service.

Most of the technology to filtrate the waste engine oil comes at a high cost. As a result, the aim of this study is to discover a low-cost method of producing used engine oil. This research uses the procedure that is less costlythan conventional methods due to the low cost of the acid and the moderate conditions of the process. The recycled oil from this process has been shown to be suitable for use as an engine lubricant. This thesis is divided into five chapters: Chapter 2 is a literature review, Chapter 3 is a summary of the methods used to complete the study, Chapter 4 is the results and discussion, and Chapter 5 is the conclusion.

1.2 Problem Statement

Engine oil is must be changed from an automobile after a few thousands of kilometers or when it is no longer serve a purpose that is fully reliable. Therefore, changing the engine oil would produce a waste engine oil which is a high pollutant material that requires a proper management. Waste engine oil may cause damage to the environment when dumped into the ground or into water streams including sewers. This may result in groundwater and soil contamination (Hamawand, Yusaf and Rafat, 2013). The amount of lubricating oils that is collected annually in Europe and USA is very large, approximately 1.7 to 3.5 million tons. This large amount of waste engine oils has a significant impact on both economic and environmental aspects. They cost millions of dollars to manufacture and represent a high pollutant material when disposed of. If discharged into the land, water or even burnt as a low-grade fuel, this may cause serious pollution problems because they release harmful metals and other pollutants into the environment. Therefore, Recycling the waste engine oil can be beneficial in reducing engine oil costs. However, the proposed solution for this problem mostly requires a high-costs expenses. The filtration method by using the portable waste engine oil filtration unit is a low-cost product and can be suitable to overcome the high cost of recycling the waste engine oil.

1.3 Objective

The objectives of this project are stated as below;

1. To design and simulate a portable oil filter by using SolidWorks.
2. To fabricate the portable oil filter with suitable filtrating material.
3. To test the develop oil filter compare to lab scale.

1.4 Scope of Research

The scope of the project is developed based on the objectives of the project as below;

1. Designing and testing the performance of the portable oil filter with SolidWorks andanalyzing the designed product in the spec of structure using the tools in SolidWorks.
2. Fabricating the portable oil filter with analyzed suitable oil filtration membrane and light weight, oil-corrosive durable material.
3. Testing the fabricated oil filter compared to lab scale filter unit.

CHAPTER 2

LITERATURE REVIEW

2.1 Filtration of Oil

A filter is a system that separates one substance from another by placing a filter medium inthe way of the fluid flow in order to trap the solids in some way. The filter then becomes a device that is able to hold the filter medium in the best way to achieve the purpose of the filter process. In standardized testing procedures, the quality of oil filtration is normally characterized by the filtering efficiency and filtration fineness.

2.1.1 Current Filtration in Market

Acid-clay Process

The waste oils will be filtered to remove metallic particles and debris, and the filteredwaste oils will then be reacted with sulfuric acid and clay in a reactor at a temperature of 475–625 K to make fuel. After being refiltered and cooled, the created fuel will be stored. Used oil is handled with sulfuric acid, which forms sludge by reacting primarily with oxygen, nitrogen, and sulfur-based chemicals, asphaltic and resinous chemicals, and soluble metalliccomponents. Colour and odour bodies that remain in the treatment oil are then eliminated using activated clay treatment. The main issue with the acid-clay process is the proper disposal of vast amounts of sulfuric acid-containing sludge waste.

Solvent Extraction Process

The contaminants are removed in a solvent-mixing process. The solvent extraction method is depicted in Figure 1 as a condensed, conceptual-process flow diagram. In the reactor column, used oil is combined with an aliphatic solvent such as liquefied propane. The solvent behaves selectively in this unit, dissolving the oil fraction while leaving the lesssoluble impurities. Acidic constituents in the water phase reduce the alkalinity of the circulating water, making it suitable for cooling tower use. In a distillation column operatingat atmospheric pressure, the solvent is recovered from the solvent/oil mixture, allowing condensation of the solvent vapours from the column overhead without the use of refrigeration.

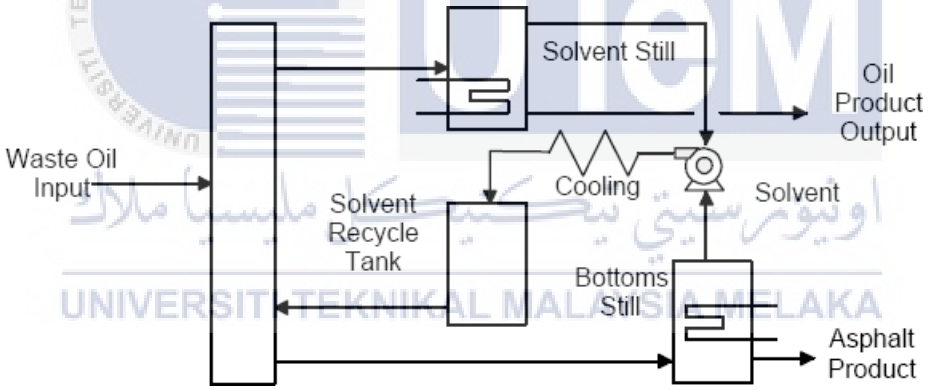

Figure 2. 1 Solvent Extraction Process Flow Diagram

Cracking Processes

The heavier, higher boiling-point petroleum fractions are broken or cracked into more valuable items such as unfinished gasoline, kerosene, fuel oil, and gas oils during the cracking process. Waste oils may be cracked using a variety of methods to be used as automotive or gaseous fuels. The main drawback is that it is an energy-intensive method thatusually requires more advanced and more expensive equipment.

The most common type of cracking is catalytic cracking. Catalytic cracking reducesthe number of residuals and increases the quality and quantity of lighter, more attractive products by breaking complex hydrocarbons into simpler molecules. The molecular structure of hydrocarbon compounds is rearranged in this process to transform heavy hydrocarbonsinto lighter fractions like kerosene, gasoline, LPG, heating oil, and petrochemical feedstocks.

Fluid catalytic cracking is the most common method, in which the oil is cracked in the presence of a finely divided catalyst that is kept aerated or fluidized by the oil vapours. Air, oil vapours, and steam are used to transport the fluid catalyst between the reactor and the regenerator continuously.

The catalysts used in refinery cracking units are typically solid materials that come in the form of powders, beads, pellets, or shaped materials called extradite. The used catalystis regenerated to remove any coke that has accumulated on it throughout the process. Most of the coke deposits burn off at the bottom of the regenerator, where preheated air and spentcatalyst are combined, as finished catalyst flows through the catalyst stripper to the regenerator. To improve the cracking process, a new catalyst is added, and the old catalyst is removed. The fluid catalytic cracking is one of the major processes, which effectively contributes to the gasoline pool (Demirbas, 2008).

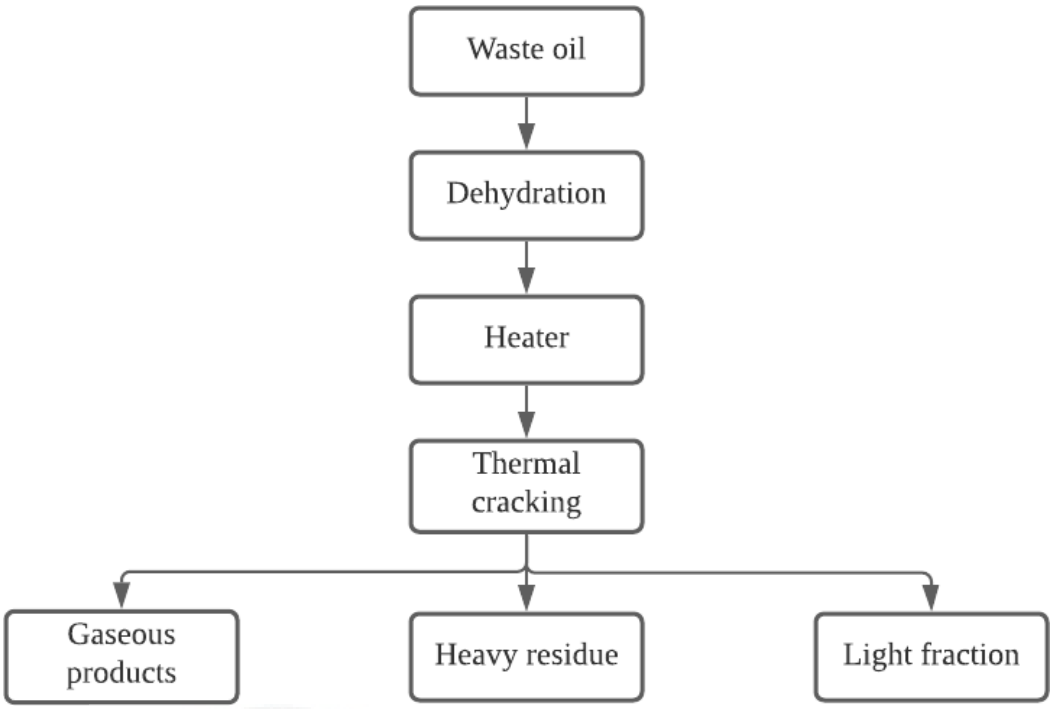

Figure 2. 2 Schematic Diagram of The Thermal Cracking Process.

Pyrolysis Processes

Pyrolysis is described as the thermal degradation of wastes in the absence of oxygenor air. Pyrolysis involves heating polymeric materials to high temperatures, which causes their macromolecular structures to break down into smaller molecules, resulting in a wide variety of hydrocarbons. These pyrolytic products are separated into three categories, gas and solid residues. Since some pollutants are present in virgin oil, the composition of wasteoils varies with use. However, the majority of contaminants are the result of the processes inwhich the oil is used. It is a hazardous waste since it contains sulphur, hydrocarbons, and metals like chromium and lead. The aim of pyrolysis is to obtain valuable liquids, which necessitates the absence of metals in the fluids.

2.2 Design Concept Evaluation

Concept generation is the most creative and indispensable step of innovation design. Many researchers have stated that there is a significant correlation between the quality of design concepts and the success of final products (Hao, Zhao and Yan, 2017). The methods developed to assist design concept evaluation can be classified into two categories, namely the non-numerical methods and the numerical methods. Typically, the former includes such methods as concept screening and concept selection (Corporation Xerox, 1987). Concept screening is a method for an organization to reduce the number of ideas for a new product or service that are typically generated. It is necessary to filter ideas against certain criteria in order to ensure that the best ones are chosen for further development. Concept selection is an activity in the product design process, where alternative concepts are compared and a decision is made to select the alternatives which proceed into the later phases of design. Generally, non-numerical methods are relatively simple and fast, and are more suitable for quick screening of design concepts for simple applications. Numerical methods, on the other hand, are more systematic and can help designers attain more accurate evaluations, particularly for complex design concepts.

2.2.1 Pugh Method

Stuart Pugh, the head of the design division and a professor at the Glasgow's University of Strathclyde, created the Pugh matrix. The Pugh technique, Pugh Analysis, the Decision Matrix Methods, matrix, decision grid, selection grid, selection matrix, problem matrix, issue selection matrix, issue selection grid, and solution matrix, criteria rating form, criteria-based matrix, opportunity analysis, and many others are some of the titles given to this matrix. The Pugh method is a qualitative technique used to rank the multi-dimensional options of an option set (Frey *et al.*, 2009). It is commonly used in engineering to make design decisions, but it may also be used to rank investment alternatives, vendor options, product possibilities, or any other multi-dimensional entity collection.

The presentation and discussion of information in the form of a matrix is a key feature of the Pugh method. The Pugh matrix's columns are labelled with a description of design concepts in drawings and text. The matrix's rows are labelled with concise statements of the criteria that can be used to evaluate design concepts. The method requires the selection of a datum, preferably a well-known and widely accepted design concept. The total process of achieving these objectives will be referred to as Pugh Controlled Convergence, or PuCC. Frequently, the initial datum concept is the market leader at the moment. Through a moderated discussion among the experts, evaluations are developed and entered into the matrix. Each cell in the matrix has the symbols 1, 2, or S, indicating whether the design concept for that column is clearly better than, clearly worse than, or nearly the same as the datum concept as determined by the criterion for that row.